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CERTIFIED MAIL-RETURN RECEIPT REQUESTED

October 6, 2009

Mr. Timothy E. Eastep, Manager
Environment, Land & Water Department
Freeport McMoRan Copper & Gold Inc.
Chino Mines Company
P.O. Box 7
Hurley, New Mexico 88043

RE: Response to comments on draft Ecological Risk Assessment, letter dated May 11, 2009
Hanover and Whitewater Creeks Investigation Unit (H/WCIU)
Chino Administrative Order on Consent (AOC)

Dear Mr. Eastep:

The Ground Water Quality Bureau of the New Mexico Environment Department (NMED) received the above referenced letter from Chino Mines Company (Chino) on May 12, 2009. NMED and NewFields Boulder LLC (NewFields), the NMED directed Ecological Risk Assessor, provide the following response.

Chino's comments were presented as a relatively continuous narrative, rather than discrete numbered comments. Therefore, the NMED responses are embedded in the original Chino text. The figures and tables cited in the responses are also attached.

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*Beginning of Chino text from May 11, 2009 letter. *

This document presents Chino Mines Company's (Chino) comments on the draft Ecological Risk Assessment (ERA) for the Hanover/Whitewater Creek Investigation Units (HWCIU) dated November, 2008. The HWCIU ERA was prepared under the Administrative Order on Consent (AOC) between Chino and the New Mexico Environment Department (NMED) by Newfields. This risk assessment is a tool used to not only assess ecological exposure to soil and water but to assist with management decisions regarding cleanup.

The ERA acknowledges that uncertainty is an inherent part of risk assessment. The ERA relied upon professional judgment or assumptions when information from the New Mexico Environment Department (NMED), the United States Environmental Protection Agency (U.S. EPA) or scientific literature was either not available or difficult to interpret. Unfortunately, because this report does little to reduce the uncertainties identified in the Site-wide Environmental Risk Assessment (Site-wide ERA; Newfields, 2005), it does not provide adequate guidance to the risk manager or the public. These uncertainties combined with layers of conservative assumptions result in hazard quotients that exaggerate the risk to vegetation, terrestrial wildlife and aquatic receptors. The sources of uncertainty discussed in the Site-wide ERA and the HWCIU ERA included:

- *Sampling uncertainty and data gaps,*
- *Uncertainty in the selection of constituents of potential concern (COPCs)*
- *Uncertainty in the natural variability in the species, populations, communities and ecosystems evaluated in the ERA as well as uncertainty regarding individual sensitivity to COPCs.*
- *Uncertainty in models and parameters used to estimate risk potentials*
- *Uncertainty in assessing background COPC concentrations that may relate to calculated risk potentials*

Below are general comments with respect to the critical uncertainties and their impact on risk conclusions.

Sampling uncertainty and data gaps. The Site-wide ERA was completed before the remedial investigations were completed for the AOC's four investigation units. Although some additional data were collected to fill spatial data gaps for soil, sediment, seeds, and foliage in the HWCIU and additional water samples were collected from streams and stock ponds, there are still significant data gaps. One significant data gap is characterizing the ongoing impact from the ASARCO Black Hawk Mill (Black Hawk) site. There are publically available NMED-approved reports for Black Hawk including the RI report, human health risk assessment report and ecological risk assessment report which could have been consulted in order to provide context on non-Chino sources and their impact on the conclusions of the risk assessment. Including this information would help fill data gaps and provide insight into critical uncertainties surrounding the conclusions of the HWCIU ERA.

Chino's investigation under the AOC revealed that ASARCO's former Black Hawk Mill, a lead/zinc mill on the other side of Hanover Creek from the Chino Mine, had been discharging significant volumes of contaminated tailings from mill tailing impoundments, across Chino's property (referred to as the "Railroad Area") into the Hanover Creek for over 60 years. The metals present in this tailing include arsenic, cadmium, copper, lead, manganese, and zinc. A summary of tailings samples chemistry from Table 6.2 in ASARCO's Remedial Investigation of the Black Hawk Mill showed total arsenic (<13 to 78 ppm), cadmium (<20 to 1,100 ppm), copper (65 to 3,600 ppm), lead (153 to15,500 ppm), manganese (457 to 2400 ppm), and zinc (567 to 30,000 ppm) in impoundment tailings (Walker, 2001). The tailing migrated to an area east of Highway 356 which has historically been a source of metals and acidity to surface water and sediment in Hanover Creek (ASARCO 1998) and although Asarco removed some of the contaminated soils in 1994 and 1995, Chino's post-removal samples showed that residual contamination remained on Chino property adjacent to Hanover Creek.

There were 21 post-removal soil samples collected by Chino in 1995 that showed elevated concentrations of a number of metals: arsenic ranges from 8.7 to 99.8 ppm (95th percentile – 47.7); copper from 107 to 993 ppm (95th percentile – 811); manganese from 1,520 to 7,880 ppm (95th percentile – 5,230); lead from 261 to 2,870 ppm (95th percentile – 1,360); and zinc from 825 to 8,090 ppm (95th percentile – 6,850). These are some of the highest concentrations detected in the investigation unit and, in many cases, these concentrations are at or exceed the 95th percentile concentrations summarized for HWCIU and Hanover Creek in Table 3.1-1 from the draft HWCIU ERA report (Newfields 2008). These elevated concentrations prove that material migrated from Black Hawk to Chino property and into Hanover Creek.

As further evidence of migration, Chino reviewed data associated with sediment and soil samples collected in 1995 for the AOC Background Report (Chino, 1995). Samples results from one tributary leaving the Black Hawk site, an adjacent overbank, and in the active channel confirm that tailings migrated from Black Hawk into Hanover Creek:

- Sample data from a un-named tributary leaving Black Hawk shows arsenic at 35.6 ppm, copper at 575 ppm, iron at 112,000 ppm, lead at 2,730 ppm, manganese at 1,410 ppm, and zinc at 678 ppm in sediment, showing migration from Black Hawk into the creek.
- Data from a nearby over-bank in Hanover Creek had arsenic at 37.4 ppm, copper at 421 ppm, iron at 61,700 ppm, lead at 1,470 ppm, manganese at 1,690 ppm, and zinc at 548 ppm.
- A sample from Hanover Creek active channel sediment had arsenic at 4.27 ppm, copper at 820 ppm, iron at 98,000 ppm, lead at 443 ppm, manganese at 1,540 ppm, and zinc at 1,870 ppm, again showing migration from Black Hawk into the Creek.

More recently, data and observations of the area during 2008 confirm that contaminated soils are still present because pH is depressed and vegetation is sparse. Soils in the area contain sulfide-bearing minerals such as pyrite. Rills are incised into the soils exposing the sulfide-bearing tailing and waste rock. This area also continues to be impacted by storm water runoff from the reclaimed former Impoundment Nos. 1 and 2 via five culverts. For example, storm water runoff in an un-named tributary leaving the Black Hawk site had 28,000 and 2,000 ppb copper in 2004 and 2005, respectively (ASARCO, 2005). The State of New Mexico has recognized that the Black Hawk Site has impacted Hanover Creek, as evidenced by a report it commissioned to assess natural resource damages due to releases of hazardous substances from the Black Hawk Site (Stratus, 2007).

These data indicate that tailing migrated into five un-named tributaries where storm runoff would flow into Hanover Creek. Since Hanover Creek is a narrow, high-gradient bedrock-controlled stream channel, deposition of entrained particles was less likely to occur along this reach. Gradients decrease near the confluence of Hanover Creek with Whitewater Creek, providing the first major depositional areas within the Hanover Whitewater Creek fluvial system. Additional sediment transport would have released Black Hawk tailing material to further down-gradient reaches of Whitewater Creek. The high flow velocity kept all particles from settling at once when the gradient initially flattened. Rather, tailing particles would continue to be transported past the confluence of Hanover and Whitewater Creeks, until the gradient further decreases and more particles settled out. Depending on the size of the rain event and where it was raining in the system, the water volume and flow would be such that sediment would be picked up and deposited at different locations. This is particularly relevant for the over-bank deposits, which result from high flow outside the normal stream channel. The over-banks received deposits of sediment load which, over time, included tailing particles contaminated with a variety of metals from Black Hawk.

To further prove the migration of material from Black Hawk into HWCIU, Chino analyzed all data pertaining to Black Hawk and HWCIU, and concluded that manganese (Mn) and lead (Pb) could be used together to trace the deposition of tailing particulate downstream of Black Hawk. Based upon the analysis, Chino concluded that Black Hawk tailing has a Mn/Pb signature consistent with the overbank and active channel sediment especially those sediments with lead in excess of 400 ppm. At concentrations less than 400 ppm, the signature relates to mineralized and non-mineralized background concentrations documented for Black Hawk and other mineralized veins located in the watershed.

Chino evaluated the other sources of Mn and Pb and concluded that none of the other sources compared to the overall mass loading of Black Hawk for the following reasons:

- The size of the three tailing impoundments,
- The location of the three impoundments relative to the Hanover Creek,
- The extremely mobile particle size associated with tailing, and
- The degraded and oxidized nature of the tailing which was un-reclaimed and exposed for 60 plus years.

Many of the 60 years of unmitigated releases were during a time when there was more water flowing in the creek system and, therefore, more flooding of overbanks. Thus, the elevated metals concentrations in the overbank areas are associated with releases from Black Hawk which include tailing, and mineralized and un-mineralized background. The Mn/Pb signature also indicates that other metals would have been transported including arsenic, copper, cadmium, and zinc.

Despite the partial reclamation activities at the Black Hawk Site, it still poses an ongoing threat of releases of hazardous substances to soil, surface water and ground water for the following reasons:

- Failure to monitor and maintain reclaimed areas to ensure that vegetation was established. At present, over 12 years after Impoundments Nos. 1 and 2 were excavated and Impoundment No. 3 was capped, the record does not indicate that monitoring or maintenance was conducted as proposed, and there are numerous barren areas subject to erosion and release of metals and acidity. Most recent storm water sampling indicates high concentrations, particularly at sampling point SW-2. Monitoring has not been conducted since 2005 (ASARCO 2005), and the site may have further deteriorated since then due to lack of repairs or maintenance to address erosion.
- The erosion documented by NMED on the Impoundment No. 3 cap has not been repaired. There is no evidence of provision for maintenance or replacement of a storm water evaporation and sediment pond, which represents a potential release point.

NMED RESPONSE No. 1

Chino asserts that the additional data collected specifically to fill data gaps in the H/WCIU were insufficient to fill the necessary data gaps. The only issue discussed by Chino under this heading

is the characterization of potential ongoing impacts from the ASARCO Black Hawk Mill site. Chino provides considerable detail related to their assertion that much if not all of the metals contamination found in Hanover Creek and its associated overbanks as well as contamination within Whitewater Creek is directly related to the Black Hawk site.

NewFields' assessment of the H/WCIU did not attempt to determine the source of the contamination found within the IU – this is a role normally addressed in the RI. Rather, the ERA was to assess baseline risks from conditions at the time of sampling to receptors potentially inhabiting the H/WCIU. The H/WCIU ERA clearly noted that elevated concentrations of cadmium and lead were highest within Physical Reaches 1 and 2 (Physical Reaches 1, 2 and 3 for lead) and 'likely represent influence from upstream sources and/or from the former Groundhog mine'. Since the influence of the Black Hawk site does not represent natural background, further analysis of the contribution of sites outside of the Chino AOC would be more appropriately considered elsewhere in the RI/FS process.

Uncertainty in the selection of COPCs. The potential COPCs in the HWCIU are metals associated with inorganics (sulfate) and acidic pH. The draft HWCIU ERA report indicates that "site-wide COPCs were selected based on a conservative screening approach that minimizes the potential for Type I error, or the potential for not selecting chemicals that are potential risk drivers." (Newfields 2008). Therefore, the HWCIU ERA did not consider background concentrations in the selection of COPCs. Because the HWCIU is highly mineralized, natural concentrations of some COPCs may exceed the highly conservative literature-based toxicity benchmarks. This fact combined with the inadequate background data used in the draft report (see below) exaggerate the potential ecological impacts from historic Chino mining and mineral processing activities.

NMED RESPONSE No. 2

Chino correctly asserts that since the COPCs identified in the Site-wide BERA were used as a basis for the selection of COPCs in the H/WCIU ERA that the H/WCIU ERA did not specifically consider background concentrations in the selection of COPCs beyond what was presented in the Site-wide BERA. The approach used in the H/WCIU ERA is consistent with EPA guidance (2002) which states that consideration of background in a risk assessment should not occur until the Risk Characterization phase, i.e., selection of COPCs should not consider background.

As stated above, the specific contribution of the Black Hawk site to COC exposures in Hanover Creek were not specifically evaluated in the ERA. In any event, these concentrations should not be considered background in this instance because both sites (Black Hawk and Chino) are subject of environmental investigations and the contamination from the sites is mixed.

Uncertainty in the natural variability in the species, populations, communities and ecosystems evaluated in the ERA as well as uncertainty regarding individual sensitivity to COPCs. The lack of habitat is a fundamental question with respect to overall interpretation of the risk results. A more detailed, multi-component conceptual site model (CSM) is needed to support the risk assessment. Individual segments of the drainages, and seasons should be considered separately if they have significantly different hydrological and hydraulic characteristics which translate into different habitat characteristics. For example, the CSM should consider the following questions:

- Where, and with what frequency, does surface water exist long enough to support amphibian reproduction or the colonization of benthic invertebrates? (i.e.: more than several months)?

- Is there a seasonal component to a contaminant source and therefore to exposure?

The HWCIU ERA makes the following conclusions with respect to surface water:

- "HWCIU is predominately composed of ephemeral sections,"

- "aquatic habitats in the HWCIU are generally limited due to lack of persistent water sources,"

- "very limited data regarding habitat quality and aquatic community presence and structure is available",

- "concentrations exceed sediment toxicity reference values (TRVs) that are potentially predictive of adverse effects on sediment organisms, if water is present long enough for colonization by aquatic invertebrates", and

- "risk predictions should be viewed in terms of quality of habitat and availability of water."

The risk assessment should not be so conservative that it results in remedial action objectives (RAOs) designed to protect ecological receptors from hypothetical exposures where physical/habitat limitations prevent the use of the resource targeted for protection.

The draft HWCIU ERA report states that wildlife habitat quality throughout the HWCIU is impacted by physical stressors associated with physical disturbance due to construction, tailing removal, and flooding, but stops short of specifically discussing the effects that physical stressors like suspended solids or lack of oxygen may have on aquatic life. These physical stressors to aquatic life exist regardless of whether there are elevated metals such as suspended solids loads or lack of oxygen.

In addition, the draft report states that the small ground feeding bird was most at risk from metals contamination and the dark-eyed junco is the species used to represent the guild. Yet the HWCIU ERA does not account for the other aspects of the biology of this representative species such as its habitat requirements, seasonality, recovery time when leaving the area, and potential population-level compensation. Specifically, the lower HWCIU corridor represents poor quality habitat for the junco, especially in areas with little to no woody vegetation for cover and lack of persistent water sources. Therefore, a fundamental question exists regarding the relevance of the ecological risk conclusions.

NMED RESPONSE No. 3

Chino raises several issues ranging from the effects of different habitat types on aquatic species to effects of physical disturbance on aquatic life to habitat requirements for a single bird species in this section of the comment document. Each general topic is addressed separately.

Conceptual Site Model (CSM) – The HWCIU ERA, and the Site-wide BERA address the issue of intermittent and ephemeral streams. The ERA included data on water quality from areas that were

observed to be inundated during normally wet periods of the year, particularly the summer monsoon season that is typical of the region. The ERA documents clearly refer to these water bodies as ephemeral and seasonal. Therefore, the seasonality component of exposure is explicitly addressed in the Site-wide, and implicitly addressed in the HWCIU ERA. In addition, the potential impact of duration of water body presence is addressed in the planning stages referring to fauna for which temporary water bodies are important habitat resources.

The statements quoted by Chino from the conclusions in Section 4.3 of the H/WCIU ERA correctly highlight the ephemeral nature of the aquatic system within H/WCIU, however, the comments fail to place those selected statements into the context presented in the conclusions section. With respect to surface water, the conclusions state; "In most cases where surface water exists in the H/WCIU, copper concentrations are elevated over acute and chronic water quality criteria'. This includes areas that contain water for prolonged periods of time, extending far beyond the brief periods where flow is present in the main channel in response to precipitation. In arid areas, small areas with persistent water can be highly important to aquatic life and such areas are presented within and represent the most important aquatic habitat within the H/WCIU. These areas include stock tanks, ranch ponds and persistent pools in Hanover Creek, Whitewater Creek, Lucky Bill Canyon and Bayard Canyons.

The State water quality criteria were used in the ERAs as risk-based benchmarks for screening and risk characterization. As stated in the H/WCIU ERA and codified in 20.6.4 of the New Mexico Administrative Code (NMAC), ephemeral and intermittent waters of the state must meet acute water quality criteria while perennial waters must meet chronic water quality criteria. The State has not formally classified the drainage segments in the H/WCIU. Thus, the risk assessment provided comparisons to both acute and chronic water quality criteria, with the expectation that Risk Management decisions would incorporate the nature of a given water body.

Given this information, it is unclear where the concern related to the conservatism in the risk assessment is based. Decisions related to Remedial Action Objectives (RAOs) will be created as part of the Feasibility Study (FS) where Applicable or Relevant and Appropriate Requirements (ARARs) will be considered. Such considerations will include the applicable water quality standards which must be met according to NMAC 20.6.4.

Habitat and Physical Stressors – Chino notes that the potential effect on aquatic communities from suspended solids and dissolved oxygen. These factors are not specifically discussed in the H/WCIU ERA, but are clearly embodied in the discussions of ephemeral and intermittent waters in arid and semi-arid environments. Specific discussions can be added to the ERA.

The dark–eyed junco was cited as a representative species for small ground feeding birds. In essence, this simply meant applying a name to a generic scenario to represent small-bodied, ground feeding birds that inhabit the site and complete reproduction and rearing at the site. Therefore, the migration and other temporal aspects of junco behavior cited by Chino (here and later in the comment document) are really not relevant unless all species at the site have similar migratory behavior.

Uncertainty in risk characterization using laboratory based toxicity values and the HQ approach. The ERA acknowledges that uncertainty is created when information gained in a laboratory setting is used to extrapolate to conditions in the natural environment. The Site-wide

ERA identified a number of site-specific uncertainties related to laboratory toxicity testing and terrestrial plants. Plant laboratory toxicity tests on Chino soils were conducted on naïve (plants that have not adapted to a metals-enriched soil), herbaceous agricultural plants. These plants are not representative of plants growing on HWC soils for the following three reasons:

- First, some plant species adapt and thrive in mineralized areas, developing more resilience to metal concentrations than naïve plants. As such, plant toxicity tests on naïve species are unlikely to represent the phytotoxic effects on adapted plants (Loneragan et al. 1981, Tyler et al. 1989, McNair 1990, Ross 1994, Kramer et al. 2000).

- Second, agricultural plants used in the tests are much more sensitive to copper than native plants, even if the native plants were naïve. On behalf of NMED, Dr. Edward Redente stated in a letter dated January 9, 2004, "Recent studies published in the literature show that native perennial species have higher toxicity thresholds than species like alfalfa and ryegrass", which were the species used in phytotoxicity tests. This statement is supported by his research (Paschke and Redente 2002), which shows native plants on western rangelands in the United States had about 1 ½ to 3 ½ times higher soil or tissue threshold levels of copper that affect shoot or root growth than agronomic species. Native plant populations colonizing mine spoils are naturally more resilient than artificially-bred agricultural species and have had time to develop tolerances (Kruckeberg and Wu 1992) by either excluding metal ions from uptake, detoxifying metal ions via sub-cellular compartmentalization or binding, or by developing specialized metabolic pathways and enzyme adaptations (Berry 1986). Such adaptations can occur rapidly, sometimes within a few years of disturbance (Tyler et al. 1989) if species contain the natural genetic variation required (Turner 1994). Adaptation may explain why range condition is fair to good in some locations with pCu less than 4 (based on rangeland condition study at Chino in 1997).

- Third, native woody plants, common in the HWC corridor, were not tested. Native woody plants are expected to accumulate metals to a much lesser extent than herbaceous species because they root deeper in the soil where copper concentrations are lower (Hobbs and Streit 1986). Most of the elevated copper levels along Hanover Whitewater Creek were in the top six inches, with the majority in the top inch.

The phytotoxicity regression slope and thresholds could change if native species are tested.

The HWCIU ERA speculates that these uncertainties should affect the conclusions to a small degree because of the canopy cover and richness correlations with pCu. As discussed in the technical comments below, the distribution of apparently affected areas may be much lower than suggested in the ERA if vegetation sampling had been unbiased and if channel sediment estimates are removed from the risk analysis.

The HWCIU ERA also does not adequately address the alterations of habitat caused by grazing, flooding, or mining-related earth moving activities. The ERA does not distinguish if the relative denudation of some areas in the riparian zone is from grazing or from elevated metal concentrations.

NMED RESPONSE No. 4

The sources of uncertainty cited in Chino's comments are all explicitly recognized in the Site-wide BERA, the HWCIU BERA, or both. Because no individual line of evidence is without uncertainty, multiple lines of evidence (i.e., lab phyto- toxicity testing and field measures of community) were used together in the basic analysis presented in the Site-Wide to develop the DELs and PELs used for risk characterization for individual IUs.

Chino's comments suggest that Site plants are adapted to mineralized soils with elevated copper concentrations. NMED does not disagree that such adaptations occur. However, copper concentrations in much of the H/WCIU corridor are elevated and pH depressed due to mining and mineral processing activities at the Site. Phytotoxic effects are apparent in the most affected areas of the Site, particularly in the downstream areas of Whitewater Creek, and lab phytotoxicity was correlated with pCu2+ in soils collected along a pH and concentration gradient at the site. The levels of cupric ion activity that were found to be associated with vegetation effects in the Site-wide BERA are clearly beyond those attributable to background concentrations of copper concentration or depressed pH, and representative of altered conditions due to mine site activities.

The regression slope and thresholds calculated using the laboratory phytotoxicity tests may change if native species were tested, but the degree and direction of change are unknown. At the time the studies were defined, investigators weighed the advantages and disadvantages of using native/acclimated plants vs. standard test species, and the costs of doing both. Standard test species were used at the time of the investigation because their performance in laboratory tests, and responses to toxicants were well understood, and performance in tests using site soils could be more definitively interpreted. Before additional testing is undertaken, it is recommended that the potential impacts on site risk management decisions be considered.

It is also noted that adverse effects to the assessment endpoint (vegetation community as a wildlife habitat) may also occur due to a species composition shift based is of lesser quality as wildlife habitat than the native community. Uncertainties based on the ecological relevance (in terms of the assessment endpoint) were discussed in the H/WCIU ERA. However, as discussed in the H/WCIU ERA, the conclusions of the Site-wide BERA and H/WCIU ERA are based on multiple lines of evidence and there is clear evidence of the potential for effects, both laboratory and field measured and field observed, in the areas where soil copper concentrations are most highly elevated and soil pH levels are most depressed due to deposition of mining-related material along Whitewater Creek.

Finally, the comments surmise that the distribution of affected areas may be much lower than suggested in the H/WCIU had phytotoxicity sampling been unbiased and if channel sediment estimates are removed from the risk analysis. Related to the biased nature of the samples, the samples collected as part of the ERI were collected using a gradient approach, by Chino, in order to provide maximal data from which the regression model could be developed. Such a model required a range of copper concentrations and soil pH to determine the effects of those measures on community composition and plant growth endpoints.

Regarding the use of 'channel sediments' in the pCu analysis; active channel and channel transect samples were excluded from use in the assessment of risk vegetation community endpoint in the ERA(s), and were excluded from the gradient analyses in the Site-wide BERA. Soils/sediments from the Side Channel area and Lower Whitewater Creek where samples were identified as either active channel or channel transect

composites but were outside of a defined stream channel where physical effects of flowing water could have a major impact on the vegetation community. The text of the H/WCIU ERA will be modified to clarify the use of these data.

The comment document also highlights the potential uncertainties related to cattle grazing as it relates to the vegetations community endpoint. The H/WCIU ERA cites the Site-wde BERA where the potential effects of cattle grazing on the vegetation community endpoint model is discussed in detail. The effect of grazing must be considered, but no data showing the effect of grazing in riparian areas versus ungrazed areas with similarly low pCu values is available. Qualitative observations within the Lower Whitewater and Side Channel areas suggest that in the areas with low pCu values and clearly visible differences in vegetation community structure and cover are within grazed areas but there is no apparent reason why grazing would be greater and the subsequent cause of the visible differences in vegetation. A discussion will be added to the H/WCIU ERA related to this topic.

The Site-wide ERA also acknowledges that there is no clear consensus from either U.S. EPA guidance or scientific literature concerning the significance of one level of hazard quotient (HQ) to another. The Site-wide ERA also addresses how an HQ of greater than one by itself does not indicate the magnitude of effect nor provide a measure of potential population-level effects. The example that the Site-wide ERA uses to illustrate this point is a high sediment HQ for a chemical in a small isolated area of high concentration, rather than widespread contamination. Although Chino recognizes that the HQ approach is used and accepted based upon professional judgment, the level of uncertainty is further magnified by uncertainty in assessing background levels of COPCs, see more detailed comments below.

The comment document presents several uncertainties related to the laboratory testing of plant toxicity and the resulting model developed in the sitewide BERA and their effects on the H/WCIU ERA. Chino has made similar comments on the sitewide BERA and the Smelter and Tailings Soils Investigation Unit (STSIU) ERA.

NMED RESPONSE No. 5

Chino highlights some of the uncertainty in the Hazard Quotient (HQ) model used in the Site-wide BERA, H/WCIU ERA and most ERAs conducted using USEPA guidance. The comments indicate that the level of uncertainty in the conclusions reached using the HQ approach is magnified by uncertainty in assessing background levels of COPCs. In mineralized areas, receptors may be able to tolerate higher concentrations of COPCs present at natural background concentrations. That does not, however, indicate that uncertainty in HQs calculated in areas where COPC concentrations are higher than background are less indicative of the potential for effects.

Uncertainty in models and parameters used to estimate risk potentials. The Site-wide ERA acknowledged much uncertainty in the food web models used for the small ground-feeding bird, which rely on allometric equations and simplistic assumptions. For the HWCIU ERA, there was an opportunity to update these models using more species-specific information available on diet, body weight, and ingestion rates, and site-specific information on bioavailability and bioaccumulation factors (BAF), but this was not done. The same BAFs were used without evaluating the effect of retaining reference areas and using unwashed vegetation and seeds to calculate the median BAF. The HWCIU ERA identifies uncertainty in the bioavailability used but the conclusions focus on results with unrealistically high estimates of bioavailability that do not account for site-specific bioavailability tests available for lead from Black Hawk Mine studies or adjust for the form of the metal used in the study upon which the TRV was based. Similarly, the potential risk estimated for amphibians is based on uncertain parameters, such as an unbounded TRV for copper. As discussed below under Technical Comments, the lack of effort to update the models results in an exaggeration of risk.

NMED RESPONSE No. 6

The comment document indicates that 'lack of effort to update the models [used to calculate risk to terrestrial wildlife presumably] results in an exaggeration of risk'. The comment argues that more species-specific information was available for use in the H/WCIU ERA than was available in the Site-wide BERA. The Site-wide BERA was developed to provide a background and baseline for use in IU-specific ERAs. Therefore H/WCIU ERA (and the S/TSIU ERA) were primarily based on the tools developed in the BERA. [But see Response No. 10 below.] The uncertainty of such data use was discussed in the H/WCIU BERA and it indicates that risks may be over- or under-estimated to an unknown degree by using this approach. Where location-specific collocated food and prey data were available, those data were used instead of the BAFs specifically to address this uncertainty. Had food data been available at all sampling locations, it would have been used in preference to the more uncertain BAF approach toward estimating exposure via food ingestion. These results were more heavily weighted in drawing conclusions for the wildlife receptors.

The comment also suggests that the bioavailability factors used in the risk model were 'unrealistically high'. The H/WCIU stated; 'The actual bioavailability of copper [from ingested soils] is almost certainly less than 100%, but is unknown for this site. Therefore, for calculation of SSLs [soil screening levels], a range of bioavailability from 10% to 100% was used. Mapping of HQs calculated using both 100% and 50% bioavailability from soils was presented in the H/WCIU ERA. For lead, a 25% bioavailability factor from soil was used. Chino's rationale for lowering lead and copper bioavailability are based on studies conducted to estimate soil bioavailability to human children and based on the proportion of grit ingested by the small ground-feeding bird receptor. Discussions of these uncertainties and data will be added to the H/WCIU ERA. However, as can be seen in ERA Table 3.2-1, copper concentrations in the area predicted to have the highest risk to small ground-feeding birds, bioavailability as low a 10% would still result in elevated risks to those species. While not expressly presented in the H/WCIU ERA, lead bioavailability at half of the current 25% used would similarly result in little change in the conclusions of the ERA.

Uncertainty in assessing background COPC concentrations that may relate to calculated risk potentials. The conceptual site model (CSM) that was used in the Site-wide ERA was developed before the remedial investigation for the HWCIU was completed. As a result the CSM does not address the complexity and significant temporal variability associated with the HWCIU. Background concentrations of metals vary along the length of the Hanover and Whitewater Creek drainages and there are non-Chino sources of metals and depressed pH as mentioned previously. Newfields acknowledges that the reference (background) areas "were not intended as ideal reference areas in the traditional sense".

The HWCIU ERA states that metal concentrations have apparently been increased and soil pH decreased by historic mining operations in some areas of the HWCIU. What the report does not address is naturally mineralized background, which would provide context for the elevated metals concentrations throughout the IU.

The HWCIU is located in a complex geological setting within the transition zone between the Colorado Plateau and the Basin and Range physiographic provinces. Igneous units in the northern reach of the HWCIU include the Santa Rita Stock which is the copper porphyry deposit mined by Chino and the base metal mineralized halo which contains lead, zinc and silver. The Black Hawk mine lies within this mineralization halo. Naturally mineralized conditions (elevated sulfide mineralization such as pyrite) associated with the ore body likely affected surface water and ground water before mining began. These rich mineral deposits are the reason why the Apaches, Spaniards and Mexicans all collected native copper from the area and open pit mining continues to this day. The Black Hawk Screening Ecological Risk Assessment (NMED, 2001, Gradient, 2000) description of the Black Hawk site illustrates this point:

> *"Veins and mineralization at the Black Hawk site are thought to be related to the well-mineralized and altered Laramide Santa Rita stock. The Black Hawk site displays numerous bedrock outcrops with a thin layer of soil or highly weather(ed) rock. A strong gossan is evident at the site which represents the surficial evidence of oxidized remains of mineralized veins and fault structures of lead-zinc-silver deposits."*

Underground mining began in this region in the early 1800's and continued through the mid-1970's. For example, Black Hawk Consolidated Mines and ASARCO operated the Black Hawk mill and three tailing impoundments from 1919 to 1949. These three impoundments remained at their original locations un-reclaimed for over four decades until 1994. There were no environmental permits in place to regulate storm water run-off, reclamation, reseeding, or closure during the 60 to 70 year period from the start of operations until 1994. In 1994 to 1995 prior to an AOC with the NMED, ASARCO voluntarily removed Impoundments No. 1 and 2. As discussed above, over the 70 year period of time, the impoundments released sediment particulate during storm events that ultimately was deposited on the over banks associated with HWCIU. The particulates contained elevated concentrations of arsenic, cadmium, copper, lead, manganese and zinc that accumulated over time onto these over bank areas which are essentially floodplains.

The NMED-approved ASARCO RI addresses background in a detailed manner and concludes that there are areas of mineralized and non-mineralized background (Walker, 2001). Mineralized background includes concentrations of cadmium up to 18 ppm, copper up to 455 ppm, lead up to 3,591 ppm, manganese up to 23,180 ppm, and zinc up to 10,520 ppm (see Table 2, GeoMegoa 1999), respectively, which are well above concentration ranges reported by Golder (2004) for HWCIU. The Black Hawk site released metals into HWCIU and increased background concentrations above those documented as "pre-mining" by Golder (2004).

As addressed in the Technical Comments presented below, zinc is the main risk driver on Hanover and Whitewater creeks north of Lake One. Copper and lead are actually within the background range of metals in seeds and foliage and zinc is the only metal that exceeds its respective background concentration range. Based on the comments presented below, copper does not drive risk to birds in Hanover and Whitewater creeks.

The Black Hawk Screening Ecological Risk Assessment (NMED, 2001, Gradient, 2000), which was approved by NMED, addressed the issue of naturally elevated background concentrations of metals as follows:

- *"Because of the presence of naturally elevated metal concentration in soil in the general area, potential impacts to plants, invertebrates and microorganisms are unlikely."*;
- *"Although certain areas with soil metal concentrations significantly elevated when compared to background concentrations could be associated with limited impacts to ecological receptors, the limited area coverage of these locations and site-specific conditions would indicate that exposures using the food web modeling may be over-estimated."*, and
- *"The overall background concentrations of lead, zinc, copper and manganese are relatively high in the two major soil types at the Black Hawk Mill site (Walker, 2000). Concentrations of metals range over several orders of magnitude...Separation of the data by soil type provides a more realistic comparison of richly mineralized* ***versus*** *(emphasis in original) slightly mineralized soil types. The data show that the Santa Fe Complex soil is much more enriched or mineralized than the soil samples from the Oro Grande complex."*

The draft Record of Decision prepared by NMED in 2005 also recognized that natural background concentrations of lead were "well above" the U.S. EPA's soil screening guidance level of 400 ppm (NMED, 2005). The draft ROD then concluded that a comparison of site and adjacent soil hazard indices indicates that "little additional ecological risk exists due to soils potentially affected by tailing".

Because the ERA does not adequately address the issue of mineralized background in the HWCIU, the level of uncertainty related to the conclusions about exposures and habitat impact will make it difficult to develop meaningful pre-feasibility study remedial action criteria.

NMED RESPONSE No. 7

Please also see NMED Response No. 1.

There is no doubt that mineralized soils are present at the site. However, there is also ample evidence that Hanover and Whitewater Creeks as well contain elevated COPC concentrations related to mining operations in the area. The H/WCIU clearly indicates where sources of elevated COPC concentrations may be related to sources other than Chino. As discussed previously, the H/WCIU assessed the baseline risks to ecological receptors within the H/WCIU. NewFields believes that further analysis of the contribution of sites outside of the Chino AOC to the contamination within the H/WCIU is outside of the scope of the ERA and should be considered elsewhere in the RI/FS process. The citations provided from the Black Hawk Screening Ecological Risk Assessment have no bearing on the conclusions reached in the H/WCIU ERA.

Chino also asserts that zinc is the primary risk driver north of Lake One and that copper is within the background range of metals in seeds and foliage. No reference for such an assertion is provided. Zinc is certainly present at elevated concentrations in several locations but the suggestion that copper and lead are not contributors to the risk to ecological receptors in that area (regardless of source) is incorrect.

TECHNICAL COMMENTS

Vegetation Assessment

<u>Phytotoxicity Tests</u> – As outlined in the uncertainty discussion above plant toxicity tests on Chino soils were conducted on naïve (plants that have not adapted to a metals-enriched soil), herbaceous agricultural plants. An additional problem not addressed in that discussion is that pH changed during the phytotoxicity test, which also changed the bioavailability of copper. If the starting pH was less than 6, the ending pH of the test was often much lower, up to 1.3 pH units lower. If the starting pH was higher than 8, often the shift was upward. The calculated pCu was not adjusted to account for the change in pH during the test. A few soil samples that experienced such a pH shift were key to defining a threshold of pCu 5 to support the ERA recommended probable effects level (PEL) of pCu 5. If the pH shift is applied to the pH reported for each soil in the ERA (using 3rd sample to match location of collected sample for the test, Figure 1), the threshold may be as low as pCu of 4 because a soil shifts from pCu 5 to 4 (see arrow in Figure 1). The boundary for probable effects becomes less certain with this adjustment.

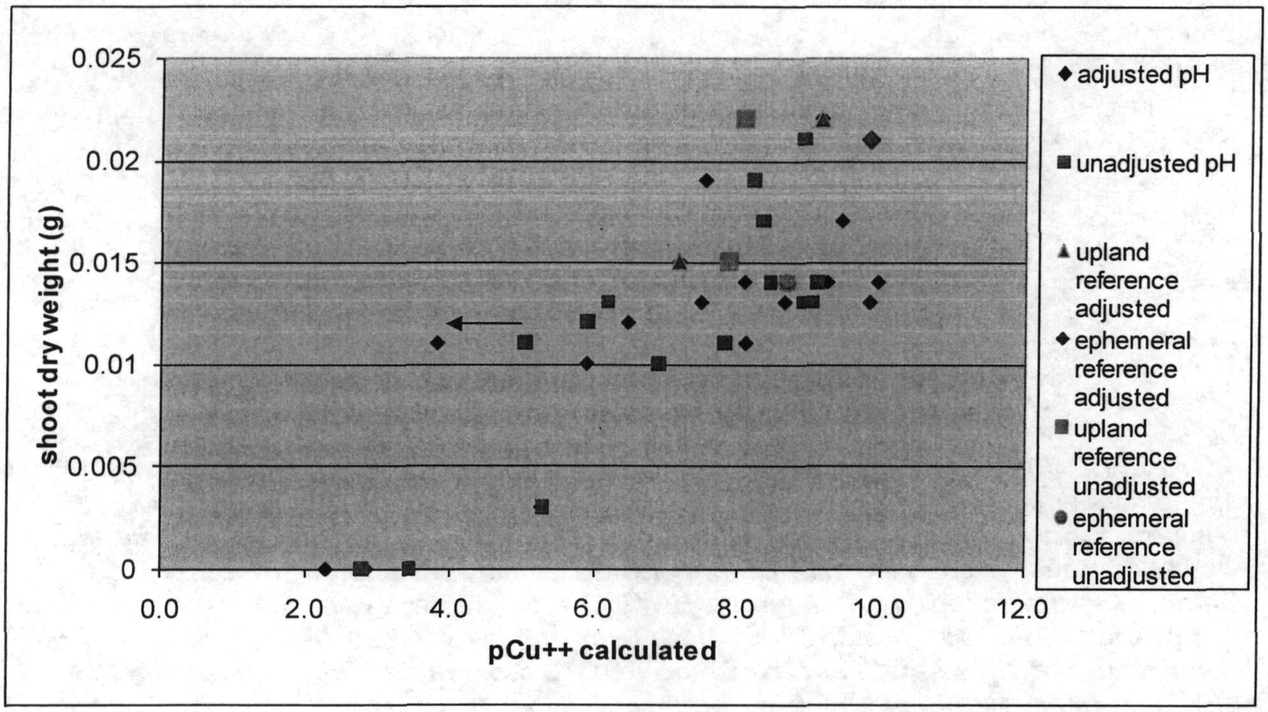


Figure 1. Relationship between calculated pCu and alfalfa shoot dry weight using unadjusted pH reported for the third ERA sample at each site and using pH adjusted for pH changes observed during the phytotoxicity test.

<u>Sampling of the Vegetation Community</u> – Because the transects used to sample vegetation community variables were not selected in an unbiased, random manner it is not known if the vegetation cover and richness analysis discussed in the Site-wide ERA is representative of the HWCIU. For example, if bare areas are selected in areas with high metal concentrations and high cover areas are selected in areas with low metal concentrations, the regression of copper

versus canopy cover could be biased. The Ecological IU RI Report included photographs of sampled sites, which showed the potential bias in sampling locations with respect to vegetative cover (ARCADIS JSA 2001). Because the HWCIU is spatially variable, unbiased sampling is required to correctly estimate the extent of the area affected by metals on the creek over banks and bars.

NMED RESPONSE No. 8

Sampling of the Vegetation Community

Sampling areas within the H/WCIU were selected based on a gradient of copper concentrations and soil pH. The general locations were selected primarily based on copper and soil pH values. The habitat in the S/TSIU is naturally patchy in some areas, and the objective of the sampling was to assess conditions in the vegetated areas. So, in contrast to what's suggested in the comment, specific locations were selected to include vegetation so that tissue samples and community metrics could be obtained. The gradient approach was selected in consultation with Chino and EPA so that a model could be developed to be used as a tool to predict areas where effects to vegetation are expected without requiring expensive field-level vegetation surveys of the entire area.

Additional, more extensive surveys and testing could be completed to more thoroughly characterize uncertainty in the model and potentially alter resulting risk management criteria. However, before such an effort is expended, NMED recommends an evaluation of the impact various outcomes of such an evaluation on overall risk management decisions.

Of the 16 locations from which soils were tested in plant toxicity tests, 56% (9 of 16) showed a decrease in pH during the tests, and 44% increased in pH. The average decrease was 0.57 units, whereas the average increase was 0.62 units. Decreases in pH occurred throughout the range of initial pH values, whereas increases in pH occurred primarily between pH 6 and 7. The largest changes (increases or decreases) were for samples with initial pH values between 6 and 7 (Figure 1).

In the Site-wide ERA Figure 2.5-1, the test endpoints were plotted against the pCu2+ in the soil extracts used in ion-selective electrode measurements. Data are not available for pCu2+ in soil extracts from phytotoxicity test initiation and termination. So, for this comment response, pCu2+ was calculated based on copper and soil pH, using the pH measured by the phytotox testing lab at test initiation and termination (See Attached Figure 2.5-1-A and B-REVISED). When these pCu2+ values are plotted against the test endpoints, results look somewhat different than when the extract data were used. When initiation pCu2+ values are used, the results could be interpreted as increasing the PEL from 5 to 6, based on the change in performance between tests at about 5.5 and 6. When Termination pCu2+ values are used, they reveal a gap between pCu2+ 5 and 7 because pCu2+ results in this range either shift down to below five or up to seven. Selection of a PEL from these results is more difficult because of the gap in data between 5 and 7. However, they could indicate an increase in the PEL. The impact on the DEL is more apparent, where the DEL could be shifted to 7-8, instead of 6-7.

Predictions of pCu - Because vegetation does not grow in the active channel, channel sediments should not be used to calculate pCu exposure to plants. The introduction of the HWCIU ERA states that active channel sediments and point bars were not included in the exposure analysis for wildlife receptors because "these areas lack habitat that would be used by wildlife." However, in Lower Whitewater Creek and the Side Channel, active channel sediment was used to estimate pCu. In addition, the analysis including associated figures indicates that point bar data was included for all areas of the IU. Chino requests that the draft report be modified to clarify the use of the data.

The draft ERA's predictions of pCu are not necessarily reliable because of biased sampling vegetation transect locations and inclusion of active channel and point bar data. Moreover, the draft ERA's predictions of pCu are not necessarily reliable because inadequate verification of prediction effects. A few samples with measured pCu, phytotoxicity data, or community data are available in the HWCIU to verify the predictions of poor plant performance at pCu < 5 in the locations shown on the maps. Sample ERA 29 is listed as having significantly lower alfalfa emergence than upland sites but this site had high shoot growth in the phytotoxicity test (mean = 0.017 g dry weight) and high measured pCu in the soil (8.31). Only ERA 23 and 26 had a measured pCu < 5, and, of these two, only ERA 26 showed poor plant performance in the field. As the HWCIU ERA points out, Sample ERA 23 had low measured pCu (3.46) but high (31) species richness and relatively high (52%) cover when compared to Sample ERA 26 with low richness (4) and cover (29%).

NMED RESPONSE No. 9

Predictions of pCu.

Samples collected from the Lower Whitewater Creek and Side Channel areas were described as active channel samples but in both cases, the samples were collected from areas of historic and infrequent, even rare, overflow. Evaluation of the pCu2+ and soil pH suggests that the lack of vegetation in these areas may be due to phytotoxicity. These samples are appropriate for inclusion in the analysis and do not bias the conclusions. The ERA will be modified to clarify the source of soil samples from these locations.

Uncertainty in Prediction of Cu2+.

Vegetation community or toxicity testing results were not used in evaluating the predictability of pCu2+ from soil copper and pH measurements. The pCu2+ predictive equations were based solely on abiotic properties of soils. Prediction of pCU was shown in the Site-wide BERA to be well correlated with soil copper and pH with a very significant fit to a linear regression model ($r^2 = 0.93$).

With regard to the ability of pCu to predict effects to the plant community, as with any natural system, variability is expected in results of tox tests and exists as discussed in the comment. However, the overall trends indicate a correlation between high levels of cupric ion activity and deleterious effects on plant growth and some field measurements. The relationships between vegetation community variables and soil pCu2+ or other factors can be more fully evaluated by increasing the number of locations at which analysis is completed. Additional field-level surveys could be conducted to further reduce uncertainty in these conclusions.

Small Granivorous Bird Assessment

Food Web Models - Two types of food web models were applied to assess risk to the small granivorous ground-feeding bird. The first depended on Site-wide ERA bioaccumulation factors (BAFs) to derive soil screening levels and HQs for copper. The second depended on tissue levels in foliage and seeds. More weight should be placed on the results from the tissue-based risk assessment because, as stated in the HWCIU ERA, the median BAFs in the Site-wide ERA are not very reliable.

Even the tissue-based approach could be improved with more accurate input parameters and proper extrapolation of effects to the population level. Risk assessments for individual IUs should have refined and improved upon the Site-wide ERA as more information became available. Additional population-level information should be included to evaluate and predict the effects on populations in a more biologically sound manner, rather than relying on a LOAEL as representing population-level effects. More ecological risk assessments are using tools from the field of population biology and EPA has recently formed a work group to address how best to use the available tools to conduct risk assessments at the population level.

The comment suggests that HQs calculated using tissue concentrations should be given a higher weight over BAF-based calculations. In areas where tissue data were available, tissue data were, in fact, used directly instead of BAFs. The H/WCIU ERA and the sitewide BERA both discuss the potential uncertainties in the BAF values, but neither suggest that the site-specific median BAFs 'are not very reliable'. The median BAF values are based on site-specific data and were considered more reliable than using literature-based values.

It is also unclear what is meant by 'more accurate input parameters'. The input parameters were agreed upon during the planning phases of the sitewide BERA and are meant to provide a generalized receptor representative of the community of omnivorous and granivorous small bird species that may inhabit the Chino site. Considerable amounts of additional population-level data would been needed in order to move beyond the use of a LOAEL-based TRV to assess population-level risks. Such data are not currently available for the H/WCIU.

Input Parameters – The following input parameters to the food web model should be updated or corrected: bioaccumulation factors, bioavailability, and ingestion rates, body weight, and diet percentages.

- **Bioaccumulation Factors** - The median BAFs used for calculating HQs and SSLs were based on data that includes the reference sites, which biases most HQs in the HWCIU upward. When Chino recalculated the BAFs for the ERA sites with the upland reference locations removed, all the BAFs decreased with the exception of the lead BAF for seeds and the foliage BAF for zinc. Chino recommends replacing the BAFs in the ERA with the values calculated without the reference data (Table 1):

  As the Site-wide ERA mentioned but the HWCIU ERA did not, foliage and seed samples were unwashed, thereby double-counting soil uptake. Soil uptake should be limited to the incidental soil ingestion pathway. The effect of unwashed vegetation may be seen by plotting soil pCu against foliar or seed copper concentrations. Because soil pCu is considered predictive of toxicity, it should be more predictive of tissue concentration than total copper in the soil. As shown on Figure 2, this is not the case, most likely because total copper in the soil is highly correlated to the total copper in the soil that coats the unwashed foliage and seeds. The BAF relationship (soil to tissue) is probably driven by highly contaminated soil coating the vegetation foliage or seeds. If the seeds and foliage had been washed, the relationship between bioavailable copper and uptake into plants would be clearer and could possibly provide insight to whether any plants avoid taking up copper. The fact that the plant samples were not washed, adds another uncertainty to the determination of the junco-based SSLs in the HWC.

Table 1. Median bioaccumulation factors calculated from soil to seed and foliage tissue using data in the Site-wide ERA with and without the upland reference (Ref) sites.

Metal	Seed	Seed Ref Removed	Foliage	Foliage Ref Removed	Invertebrate	Invertebrate Ref Removed
Cadmium	0.09	0.071	0.132	0.129	0.25	0.18
Copper	0.073	0.055	0.121	0.121	0.169	0.135
Lead	0.108	0.114	0.0659	0.0639	0.012	0.013
Zinc	0.759	0.741	0.72	0.772	1.23	1.22

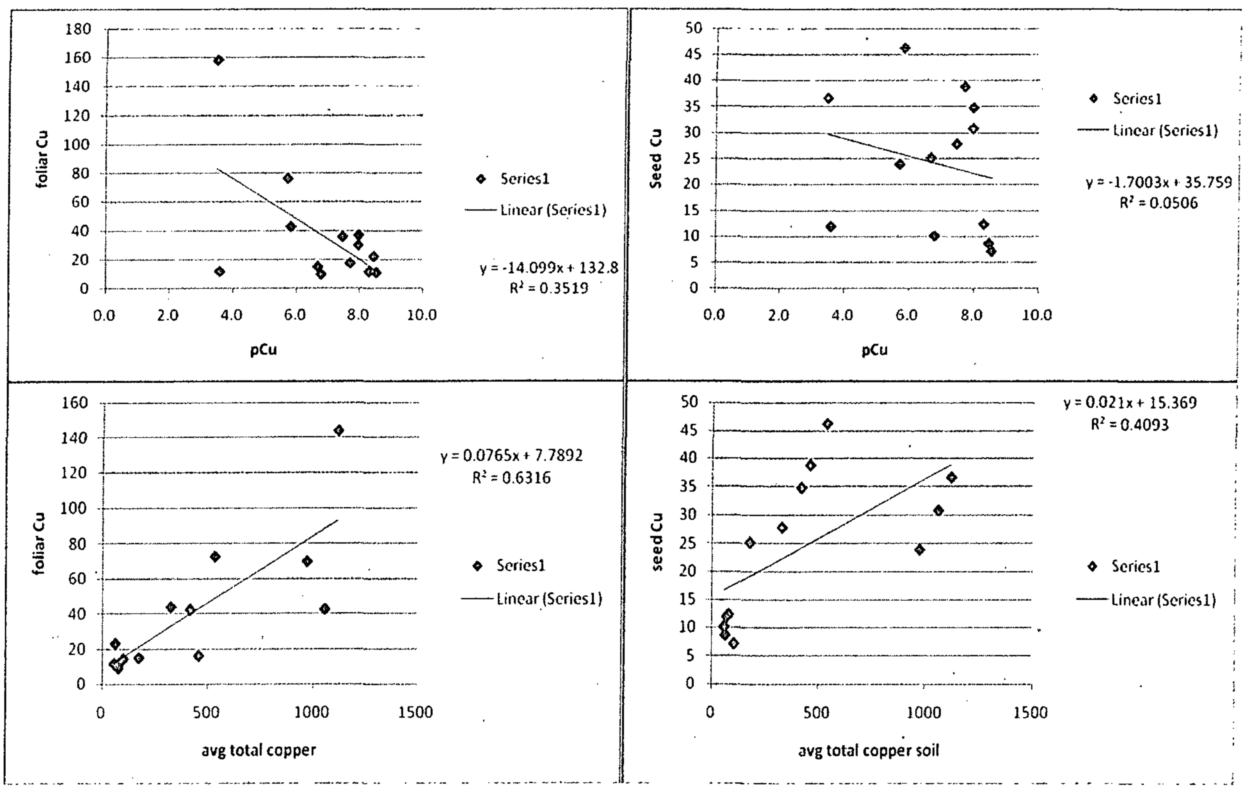


Figure 2. Comparison of the relationships between foliage and seed copper concentrations (mg/kg) with pCu and with average total copper in the soil (mg/kg).

- **Bioavailability** - Although the HWCIU ERA evaluates bioavailability from 0.1 to 1.0, the text, figures, SSLs, and conclusions focus on 25% for lead, 50% or 100% for copper, and 100% for other metals. For lead, the 25% estimate is too high according to the Black Hawk Mine analysis of bioavailability, which used *in vitro* tests to simulate a child's stomach of pH 1.5. This test, which was performed for the Black Hawk Mine Human Health Risk Assessment (HHRA; Exponent 2000), produced bioavailability estimates of local soils ranging from 1.1 to 47.1% with a median value of 3.4 and average of 13.4%. The estimate of 13% or less should be used for lead bioavailability for the HWCIU ERA because a bird's stomach pH is similar to a child's (Welty 1979) and granivorous birds are less exposed than a child because they take up more soil in the form of grit (0.2 to 1.0 mm in size, Best and Stafford 2002) to grind seeds, which has less soluble copper. Grit is sieved (0.25 mm) out of the *in vitro* samples for the bioavailability test, yet about 8% of the 10% incidental soil ingestion for granivorous birds is grit based on comparing soil ingestion of granivorous non-grit eaters to grit-eaters in Beyer (1994). The 13% estimate is too high because it is based on soil samples sieved to <0.25. The study used to develop the TRV fed chickens and Japanese quail plumbeous acetate as the form of lead, which is highly bioavailable. Thus the lower bioavailabilty recommended based on local soils is justified.

Similarly, copper bioavailability of 50% may be too high, depending on the form of copper in the soil most commonly ingested by the ground-feeding birds. The TRV study fed chickens copper sulfate, which has relatively high bioavailability to birds. The copper ingested soil in the HWC corridor may be a mixture of copper sulfates, copper carbonates, and cupric oxides and other species. Copper carbonate is 61% as bioavailable as copper sulfate and cupric oxide is not considered bioavailable to birds (<1% as bioavailable as copper sulfate, Ledoux et al. 1991). Chino suggests that speciation studies be conducted to assess copper bioavailability, rather than use an arbitrary 50% estimate.

An in vitro solubility test conducted by Chino (using the same methods as used for the Hurley copper bioaccessibilty study) on 10 samples in reaches P1-P3 produced relative bioavailability estimates averaging 32% (Table 2). Thus, Chino suggests the copper bioavailability be adjusted to 32%, if not lower to account for grit that is not bioaccessible". Chino also suggests 32% or lower for zinc, the same value used for copper. For cadmium, the TRV study used cadmium chloride, which disassociates to cadmium ion, the most bioavailable form. It is unlikely this is the main form in the soil ingested. Cadmium bioavailability should also be reduced to 32% or lower.

The HWCIU ERA uses 100% bioavailability to calculate SSLs for zinc and cadmium based on the junco exposure model, which is also too conservative. For zinc, the TRV study fed mallards zinc carbonate, the most bioavailable form. Because zinc sulfate and zinc oxide and other forms are likely present in the HWCIU, the number should be adjusted downward. For cadmium, the TRV study used cadmium chloride,

which disassociates to cadmium ion, the most bioavailable form. It is unlikely this is the main form in the soil ingested and thus the bioavailability should be adjusted downward. A speciation study would help define how much lower the bioavailability estimates should be.

- **Ingestion Rate, Body Weight, and Diet Percentages** – The ingestion rate for soil, body weight, and percentage of diet in seeds for the dark-eyed junco should be updated. A marsh wren body weight (i.e., 12 g) was used in the ERA but the correct weight for a junco is 18.2 g (average weight for pooled sexes in Arizona, Dunning 1993). The food and soil ingestion rate should also be updated from a general value for birds to the specific value for the junco which is 0.00547 kg/day for food based on Nagy (2001) and 0.000547 kg/day for soil (10% of food ingestion rate). Percentage of diet in seeds is set at 100% in the ERA but should be about 90% for wintering juncos (Beal 1910, Davis 1973, Zeiner et al. 1988-90).

Soil Screening Level and Tissue-based Analyses - The SSL and tissue-based analyses did not always show the same magnitude of hazard quotients and trends. The results should emphasize the tissue-based analysis, a less flawed approach because it does not use BAFs. The maps should show HQs for the birds for lead and zinc using the tissue-based approach in Tables 3.4-2 through 3.4-4 to spatially show the upper reach areas with risk from lead and zinc, rather than focusing only on copper SSLs. The tissue-based exposure model shows that lead, zinc, and copper have the HQ > 1 in Reaches P1 and P2 for small granivorous birds. The source of lead and zinc is likely from historic lead/silver/zinc mines and mineral processing activities (e.g., Black Hawk Tailings). Rather than lead and zinc, copper HQs > 1 predominated in the downstream reaches (although none were > 1 in P8).

In the ERA, the HQs> 1 for LOAELs for copper based on the tissue analysis in P1, P2, and the side channel are barely above one (1.1-1.2), and all HQs for copper should drop to less than 1.0 in P1-P3 when the ingestion rate, diet percentage in seeds, and body weight are updated to represent the junco receptor species, as discussed previously.

Table 3.4-3 presents a tissue-based model and HQs for an unnamed species that represents an insectivorous ground-feeding bird. Please provide more context for this additional receptor since no insectivorous species was identified as a receptor in the Site-wide ERA.

It is unclear why 95th percentile concentrations of upland soils, rather than upland and ephemeral drainage soils, were compared to the HWCIU soils to evaluate whether the HWCIU has a different exposure than the site-wide exposure.

NMED RESPONSE No. 10

NewFields re-evaluated the small ground-feeding bird exposure scenario from a range of standpoints, including varying diets, moisture composition of diets, (calculated) energetic requirements of bird species with different body sizes. Body sizes and dietary composition for a range of resident bird species was evaluated, and SSLs calculated for each species based on a range of assumptions about BAFs. This included the BERA BAFs, the median BAFs recalculated by Chino (w/o ref areas), and the regression modeling that Chino provided via email on July 9, 2009 (email from Kate Lynnes). Table 1 attached is the result of this analysis.

Dietary composition and the corresponding moisture content of the assumed diet components was a key factor in using the Nagy 2001 energetic requirement equations, and in explaining the differences in the resulting SSLs. Based on fresh-weight basis, copper SSLs for resident species of granivorous birds range from 591 mg/Kg for the black-throated sparrow to approximately 6,700 mg/Kg for the much larger mourning dove. For invertivorous species, SSLs range from 272 mg/Kg for the gray flycatcher to 6,051 mg/Kg for the northern flicker.

Thus, for granivores, it appears that higher copper concentrations in soils may be protective. However, for invertivorous species, the lowest SSLs do not change much from the scenarios calculated in the BERA and used in the H/WCIU ERA.

Comparison of tissue samples to reference sites samples - As supplementary evidence, the tissue samples should be compared to reference area tissue samples appropriate to HWCIU, which are Samples ERA 25, 30, and 34, the ephemeral drainage reference areas used in the sitewide ERA. These reference sites were not affected by Black Hawk mine tailings and have soil concentrations well below the background 95UCL of 183 mg/kg copper. For example, a comparison using interval and equivalence tests reveals that copper and lead concentrations in foliage or seed are not above the concentrations in these reference sites with any statistical certainty in reaches P1-P3. These comparisons suggest that, in P1-P3, the granivorous birds may not be exposed to concentrations of copper and lead higher than areas relatively unaffected by the mining or mineralized background. Admittedly sample sizes are low but this evidence should be discussed. In contrast, zinc and cadmium are above reference levels in these upper reaches in seeds but not foliage, as is copper in the lower reaches in foliage (seeds not tested). Lead in foliage is also above the reference sites in one location in a lower reach. This analysis and the HQs support the conclusion that the small granivorous birds in the upper three reaches are not at risk for copper, lead, or cadmium, but may be at risk for zinc.

As discussed above, the HWCIU ERA should clarify which samples were used in each analysis. Although the introduction states that point bars were not included in the exposure assessment for juncos because "these areas lack habitat that would be used by wildlife," the analysis suggests point bars were included. Also, for areas where paired soil and tissue samples were not available, nearby soil samples were averaged. The HWCIU ERA should describe which soil samples were averaged for the tissue-based analysis. Were the averaged samples within a foraging range distance for the junco?

NMED RESPONSE No. 11

No reference sites were identified in the Sitewide ERA for ephemeral drainage sites. Locations ERA 25, ERA 30, and ERA 34 are in the Smelter/Tailings and Lampbright IU's respectively. In addition, comparison of tissue levels to the tissue levels noted in those areas has no bearing on the determination of risk drivers. As was shown in the Sitewide BERA, incidental soil ingestion can make up a large proportion of the total exposure to the small ground-feeding bird receptor.

The H/WCIU ERA will, however, be modified to provide a clear explanation of the data used in the report and anywhere that samples were pooled for risk calculations as suggested in the comment.

Lack of Habitat Information for the Junco - The HWCIU ERA states that the small ground-feeding granivorous bird was most at risk from metals contamination. The dark-eyed junco is the receptor species used to represent this guild and in the food web model. As outlined in the uncertainty discussion above, the ERA does not account for the other aspects of the biology of this representative species such as its habitat requirements, seasonality, recovery time when leaving the Chino area, and potential population-level mechanisms that compensate for reduced reproduction from high metal ingestion. These factors affect the risk to this ground-feeding bird as described below.

According to habitat maps in Nolan et al. (2002) and maps and data from surveys during Christmas Bird Counts and Breeding Bird Surveys near Chino, dark-eyed juncos are winter residents (September to mid-March/early April) and migrate elsewhere to breed. This seasonal use needs to be verified to properly assess junco habitat. During the winter, juncos require trees and shrubs for cover and open ground for feeding (Davis 1973, Zeiner et al. 1988-90). Areas with moderate woody cover are best. About 20% of the HWC corridor evaluated in the ERA has poor quality habitat for the junco, with little to no woody vegetation for cover over large areas (e.g., east of TP-7, in the upper portion of the side channel, and middle portion of lower Whitewater Creek). Densities of juncos in these areas would be very low and metal exposure to the populations would be minimal in these areas due to a lack of vegetation habitat caused by flooding and/or land impacts associated with mining activities.

Davis (1973) also found junco densities were higher near a water source in the winter. Juncos can obtain their water solely from lush vegetation (CDFG 1995). But because juncos feed primarily on dry seeds in the winter, they derive less water from food than in other months. Areas close to woody cover and more permanent water sources (within 500-1000 m, Gottfried and Franks 1975) in the winter will be higher quality habitat. Rather than stratifying by physical reach to calculate 95UCLs, the area should be stratified based on habitat quality.

The birds' seasonal use of the area affects the interpretation of the reproductive TRV levels used in the risk assessment for copper, lead, and cadmium. These TRVs do not account for the recovery of the birds' condition in the breeding area. Migrating juncos leave wintering areas in southwestern Mexico in March to May (Anthony 1892, Nolan et al. 2002). The males arrive at the northern breeding grounds first, the females arrive about two weeks later, and then pair bonding and mating occurs, unless weather delays it (Nolan et al. 2002). It is unknown how long it takes birds to migrate north in the spring, possibly a week to several weeks depending on if they stay long at stopover sites and on the distance to their destination (Terrill 1987, Nolan et al. 2002). Females migrate farther and take longer.

The birds may have time to depurate the metals before forming eggs. For example, studies show lead reduces clutch size by decreasing calcium in blood plasma. But after 2 weeks without lead dosing, the egg production was back to normal (Edens and Garlich 1983). Copper levels in the liver and spleen returned to near normal within 6 weeks in chicks (Mehring et al. 1959). Time required to reduce adverse effects for the metals is shown in Table 2. These data suggest that many birds may have recovered or at least partially recovered from lead, copper, or cadmium exposure by the time they begin to form eggs. Recovery from high zinc exposure is not as likely because the effect is not limited to reproduction; zinc may cause paralysis and death at the winter site (Gasoway and Buss 1979).

If birds do not fully recover by the time they begin to form eggs and produce a reduced clutch size due to metals contamination at Chino, the reduction may be offset by increased number of birds breeding per acre in the breeding grounds. Birds compete for territories and defend them once established. Smaller clutch size might result in smaller territories to defend since less food is required for the young. Density is negatively correlated to clutch size (Both 1998, Both et al. 2000). Thus more territories can fit into the area. This compensatory mechanism may result in little change in carrying capacity or overall fecundity of the population despite the lower fecundity per bird. A population model predicting probability of a decline could evaluate such effects at the population level. As is often done in risk assessments, the ERA addresses population-level effects by using LOAEL, which is becoming outdated as more risk assessors learn to use population analysis tools. Chino suggests population modeling tools might be used to better evaluate risk to small ground feeding birds.

Table 2. Decrease in metal concentrations in tissues or blood after dosing is discontinued.

Copper (Mehring et al. 1959)				
Concentration in feed (mg/kg)	Liver Level at end of dosing	Levels 6 weeks post end of dosing	Decrease with recovery (%)	% higher than control post recovery
26 (control)	14	90	--	--
588	184	115	38	28
832	595	98	84	9
1176	820	264	68	193
Lead (Edens and Garlich 1982)				
Concentration in feed (mg/kg)	Plasma Ca at end of dosing	Levels 5 weeks post end of dosing	Decrease with recovery (%)	% higher than control post recovery
0 (control)	43.2	40.4	--	--
1	37.5	39.1	-4	Less than control
10	34.2	38.9	-14	Less than control
100	30.7	37.6	-22	Less than control
Cadmium (White and Finley 1978)				
Concentration in feed (mg/kg)	Blood level at end of dosing	Levels 30 days post end of dosing	Decrease with recovery (%)	% higher than control post recovery
0 (control)	0.003	--	--	--
2	0.005	0.003	40	0
20	0.068	0.058	15	1833[a]
200	0.33	0.102	69	3300[a]

[a] This estimate is calculated using the control value at the end of dosing not after 30 days of recovery and therefore may be inaccurate if levels in the control changed 30 days later.

NMED RESPONSE No. 12
Please see Response #3 (last paragraph).

Aquatic Assessment

Amphibian TRV - The no-effect amphibian toxicity reference value (TRV) of 0.02 mg/L used in the ERA was originally proposed in Tech Memo No. 1 (Schafer & Associates 1999), and referenced in Table 3-7 of Tech Memo No. 1 as "Harfinest et al. 1989". The full reference for Harfinest et al. 1989 was not, however, provided in the reference section for Tech Memo No. 1. The November 2008 draft HWCIU ERA provides the full reference for Harfinest et al. 1989, but indicates in the text (p 28) that the primary reference for the no-effect amphibian TRV is actually a 1976 study conducted by Porter and Hakanson (please note that the full reference for this study is not provided in the reference section of the 2008 draft). Chino requested a complete list of full references in comments on the Site-Wide ERA (2003), but only now understands that the actual primary reference for the amphibian TRV was a 1976 study. Chino has obtained and reviewed this 1976 study, and has identified the following issues that call into question whether this study provides a technically sound basis for the no-effect amphibian TRV:

- Larval tolerance for copper was evaluated by spiking de-ionized water with copper sulfate. This study was conducted prior to the development of standardized toxicity testing methods, which do not use de-ionized water to prepare bioassay test solutions. De-ionized water does not contain the proper ionic composition or buffering capacity as
- the laboratory constituted soft or moderately hard water now used to conduct laboratory bioassays. The use of de-ionized water also likely affected the toxicity of the metals being tested. The authors themselves acknowledge that the toxicity of heavy metals is "greater in soft water than in hard water" (Porter and Hakanson 1976), and current water quality criteria for copper and other metals incorporate the effect of hardness in calculating values for application.
- The 0.02 mg/L no-effect level was reported based on culturing larvae for up to 61 days, and observing that all larvae metamorphosed. The only reported effect from the study was mortality of all larvae cultured in mine drainage from Argo Mine in Clear Creek Colorado which contained 3.7 mg/L of copper and high concentrations of other potentially toxic metals including iron and zinc. Because the effect level of 3.7 mg/L reported is not in any way related to the no effect level reported of 0.02 mg/L copper, neither of these levels may be considered as "bounded levels". In other words the lack of effect observed at 0.02 mg/L could also be observed at concentrations much greater than 0.02 mg/L (possibly one or two orders of magnitude greater), even in de-ionized water.

Because significant variability may be observed in water-based amphibian no effect and effect levels across different species, life stages, endpoints, and routes of exposure, Chino recommends that an alternative amphibian TRV be used for the HWCIU ERA. The alternative TRV for amphibians should be based on a more detailed exposure assessment that describes potentially significant exposure pathways and scenarios based on an understanding of a more detailed conceptual site model (see comments on uncertainties above), habitat characteristics, hydrologic conditions, and likely amphibian use of aquatic resources (including specific species/populations exposed). Based on this assessment it will be possible to identify where and when adults are primarily exposed, where and when reproduction and development need to be protected, or where these receptors may be feeding.

Application of Water Quality Criteria – The HWCIU ERA uses both acute and chronic ambient water quality criteria to support the development of risk estimates. There is no requirement in a risk assessment context to use all potential applicable relevant or appropriate requirements (ARARs) in the risk assessment, and the ERA clearly recognizes that "in cases where the designated use is defined as limited aquatic life, such as ephemeral conditions typical in the SW part of the state, only the acute NMWQCs may be applicable". Chino recommends that only acute criteria be applied where ephemeral conditions exist.

NMED RESPONSE No. 13

Since the completion of the draft H/WCIU ERA, the U.S. Geological Survey (USGS)(under contract to the USFWS) has completed a comprehensive study of the effects of copper and several other contaminants on the federally endangered Chiricahua Leopard Frog which is known to have inhabited part of the H/WCIU in the recent past. The H/WCIU ERA will be updated to include the data described in the USGS document. Of note, the highest no-effect concentration for growth or mortality endpoints was equal to 0.003 mg/L. Reduction in body weights of the frog with chronic exposure to copper at 0.007 mg/L resulted in significantly reduced body weights when compared to the control. Length and Gosner stage endpoints were reduced at 0.047 mg/L with 0.007 mg/L as the No Effect concentration. One hundred percent (100%) mortality was observed in tadpoles exposed to 0.165 mg/L with 2 weeks exposure.

The inclusion of both chronic and acute water quality criteria was done at the request of NMED and USFWS. As noted previously, these values were used as risk-based benchmarks for toxicity to aquatic organisms. In the context of the ERA, they are not based on regulatory application. Discussion of the appropriate ARARs will occur at a later stage.

If you have any questions, please contact me at (575) 388-1934.

Sincerely,

Phil Harrigan

Phil Harrigan, Chino AOC Project Manager
Mining Environmental Compliance Section
Ground Water Quality Bureau
New Mexico Environment Department
Silver City Field Office

Enclosures: Table 1
Figure 1
Figure 2.5-1-A-REVISED
Figure 2.5-1-B-REVISED

cc: Mary Ann Menetrey, NMED
Jerry Schoeppner, NMED
Mark Purcell, USEPA
Mark Lewis, Formation Environmental (via email)
Rachel Jankowitz, NMGF (via email)
Russ MacRae, USFWS (via email)
Joel Lusk, USFWS (via email)
Ralph Perona, Neptune and Company (via email)

Table 1. Effect of Ingestion Rate Calculations and Bioaccumulation Factors on Copper Soil Screening Levels (SSLs) on Resident Small Bird Receptors

	Soil Screening Levels for Copper								
	Default (BERA) Ingestion Rates			Nagy 2001 Fresh Weight Ingestion Rate			Nagy 2001 Dry Weight Ingestion Rate		
	BERA BAF	Chino BAF	Chino Model	BERA BAF	Chino BAF	Chino Model	BERA BAF	Chino BAF	Chino Model
Granivores									
Small Ground-Feeding Bird (default from BERA)	500	614	840	566	728	1511	1389	1710	3871
Black Throated Sparrow	NA	NA	NA	591	760	1645	1439	1772	4055
House Finch	NA	NA	NA	681	876	2160	1610	1995	4724
Cactus Wren	NA	NA	NA	891	1144	3433	2023	2491	6240
Mourning Dove	NA	NA	NA	1405	1798	6691	2927	3605	9735
Omnivores/Insectivores									
Horned Lark	NA	NA	NA	568	717	1928	981	1230	5001
Western Kingbird	NA	NA	NA	446	559	1176	472	591	1350
Gray Flycatcher	NA	NA	NA	272	340	333	261	326	299
Say's Phoebe	NA	NA	NA	335	419	568	308	385	457
Northern Flicker	NA	NA	NA	982	1238	6051	1527	1914	10640

NOTES:

SSL units presented in mg/kg DW

	Body Weight	Proportion Seed	Proportion Invertrbrate	Percent Soil Ingestion
Small Ground-Feeding Bird	12 g	1	0	10
Black Throated Sparrow	13.4 g	1	0	10
House Finch	19.4 g	1	0	10
Cactus Wren	38.9 g	1	0	10
Mourning Dove	127 g	1	0	10
Horned Lark	37 g	0.5	0.5	5
Western Kingbird	38 g	0.1	0.9	2
Gray Flycatcher	12.5 g	0	1	2
Say's Phoebe	21.2 g	0	1	2
Northern Flicker	150 g	0.5	0.5	5

Ingestion Rates Calculated:

Default (BERA) — Fresh weight ingestion rate is the average of values reported for the marsh wren in USEPA (1993). Calculated based on energy requirements reported by Kahle (1965). Soil ingestion rate was estimated as Ingestion Rate * (1 - % moisture in food). Assumes seeds are 9.3% water as presented in the BERA.

Nagy (2001) Fresh Weight — *Calculated using the equation for passerine birds for Fresh Matter Ingestion (FMI) Rate reported by Nagy (2001).* FMI (g/day) = 2.438(Body Weight$_{grams}$)$^{.607}$ Ingestion Rate = FMI/Body Weight. Soil ingestion rate was calculated using the DMI rate discussed in the next bullet.

Nagy (2001) Dry Weight — Calculated using the equation for passerine birds for Dry Matter Ingestion (DMI) Rate reported by Nagy (2001). DMI (g/day) = 0.630(Body Weight$_{grams}$)$^{0.683}$ Food Ingestion Rate = (DMI/Body Weight)/(1-% moisture in food). Assumes seeds are 9.3% water and inverts are 70% water as presented in EPA 1993. Soil ingestion rate was not converted to fresh weight.

Regardless of which ingestion rate source was used, food ingestion was calculated using estimated fresh weight ingestion rates and soil ingestion was calculated using estimated dry weight ingestion rates.

Bioaccumulation Factors:

BERA BAF — Median bioaccumulation factor from all BERA sampling locations (Seeds = 0.073; Invert = 0.169)

Chino BAF — Median bioaccumulation factor from BERA sampling locations excluding reference areas (Seed = 0.055; Invert = 0.135)

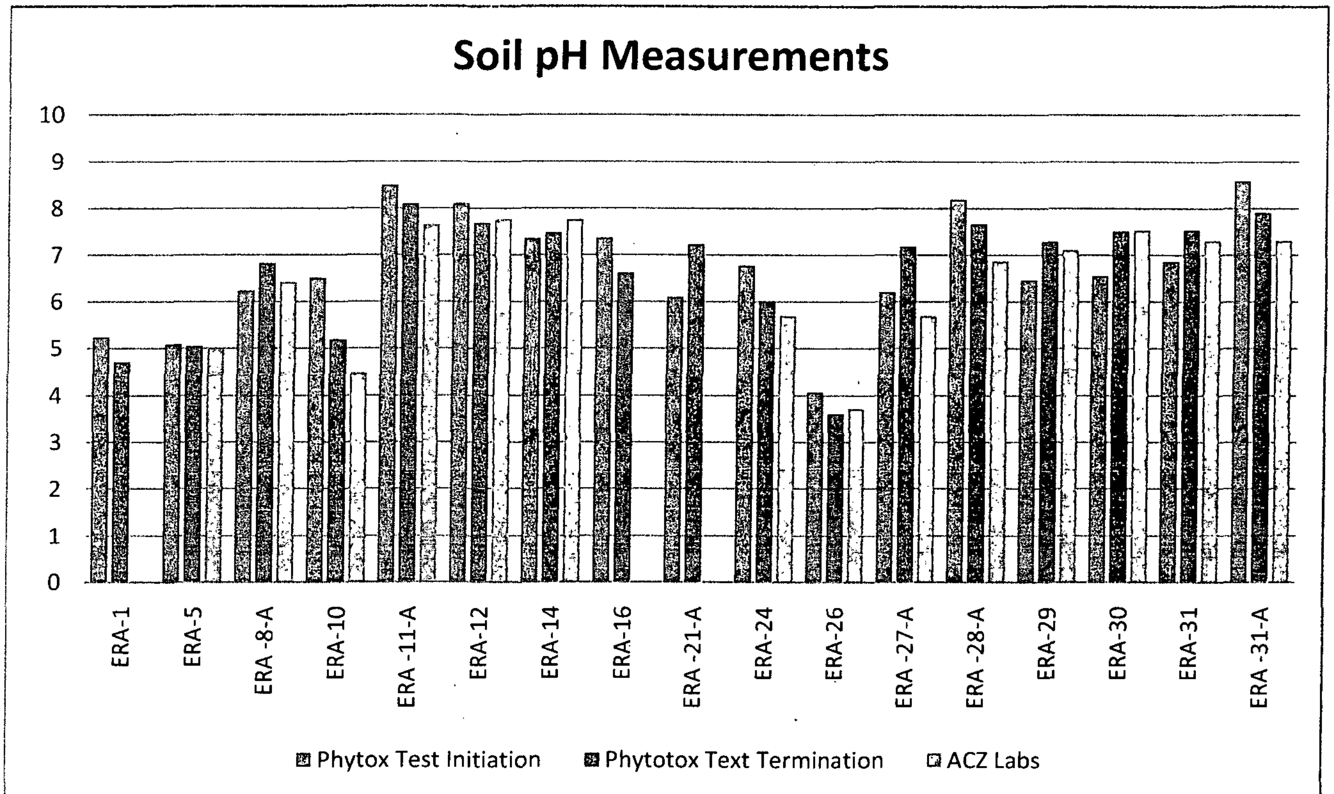
Chino Model — Regression equaltion calculated using all BERA sampling location data:

Seed: lnBAF = -0.700169 * ln(Cu) + 1.329879

Invert: lnBAF = -0.620289 * ln(Cu) + 1.622204

Calculations assume 25% bioavailability of copper from soils.

Figure 1
Soil pH and pCu2+ Measurements in Phytotoxicity Test Soil Samples



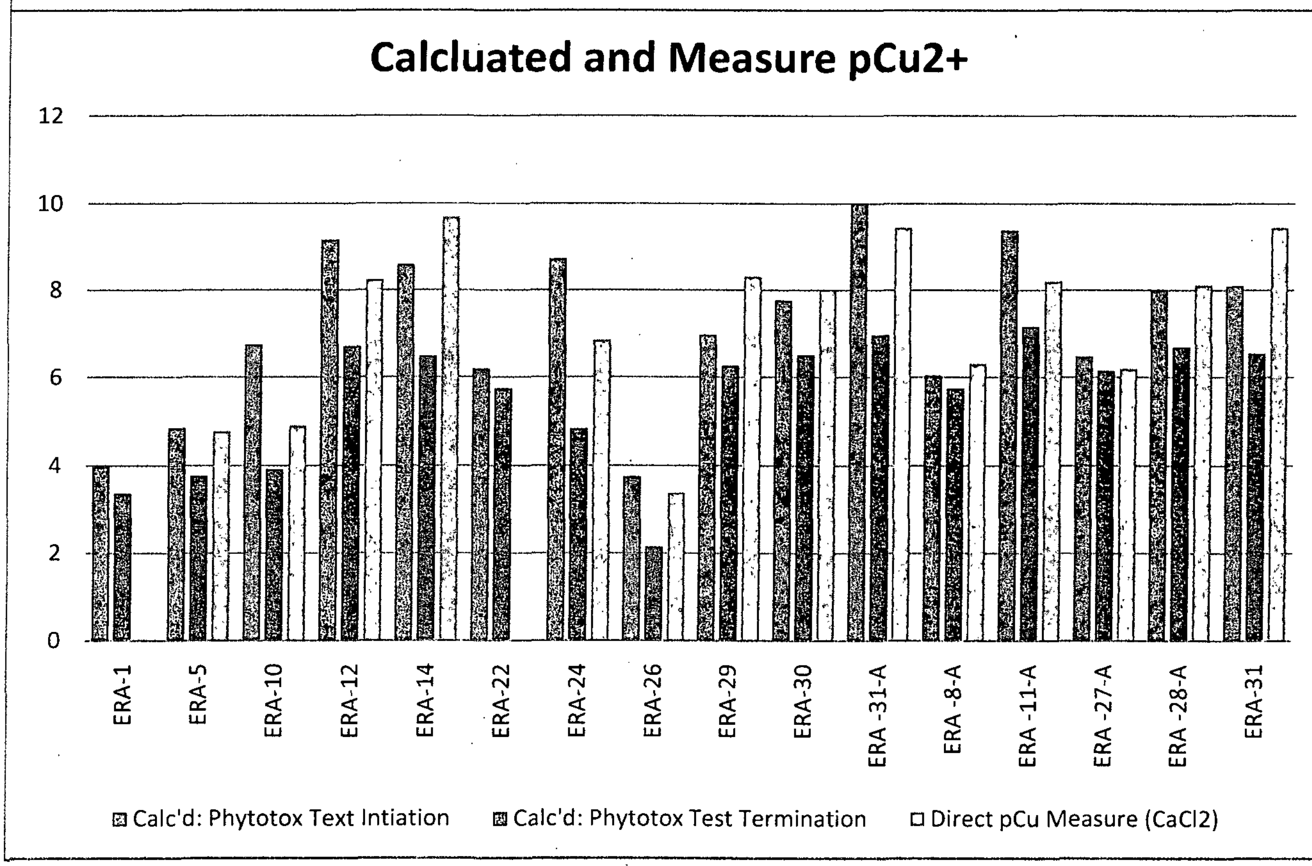


Figure 2.5-1- A- REVISED
Phytotoxicity Endpoints vs Cupric Ion Activity (pCu^{2+}): pH data from Test Initiation
Chino Mines ERA

○ significantly less than reference
● not less than reference
+ Reference (+/- 1 SD)

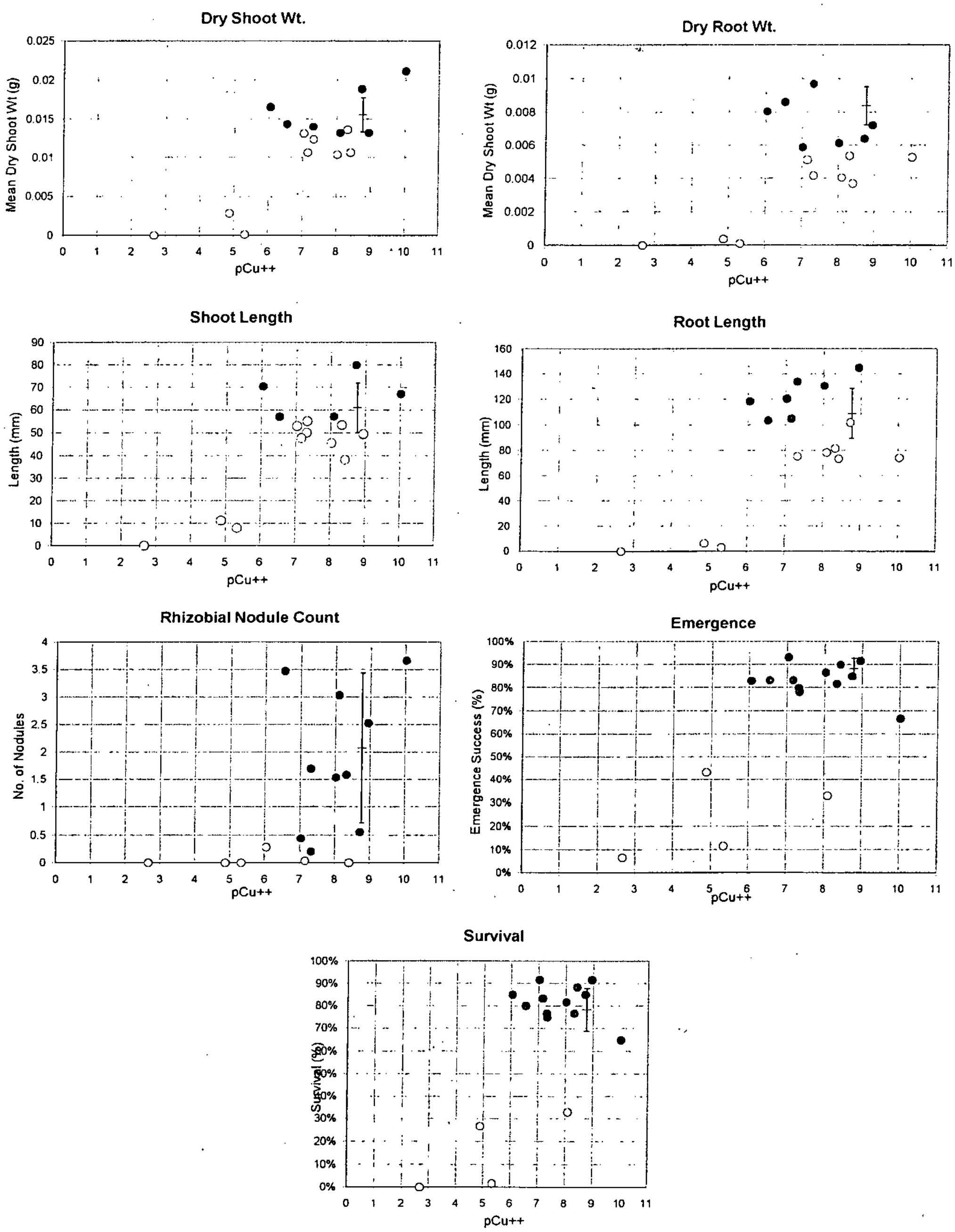


Figure 2.5-1 - B-REVISED
Phytotoxicity Endpoints vs Cupric Ion Activity (pCu^{2+}): pH data from Test Termination
Chino Mines ERA

○ significantly less than reference
● not less than reference
+ Reference (+/- 1 SD)